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(71) Applicant: **Doveri, Marco**
I-56025 Pontedera (Pisa) (IT)

(72) Inventor: **Doveri, Marco**
I-56025 Pontedera (Pisa) (IT)

(74) Representative:
Mannucci, Gianfranco, Dott.-Ing. et al
Ufficio Tecnico Ing. A. Mannucci Via della Scala 4
50123 Firenze (IT)

(54) A laterally tilting three-wheeled vehicle

(57) The vehicle possesses two steering front wheels (21A, 21 B) and a viscoelastic suspension system for said wheels such that lateral tilting of the vehicle is accompanied by an equal tilting of the steering axes (MA-MA, MB-MB) of the wheels. Each steering wheel (21A; 21B) is connected to the frame by means of an articulated quadrilateral comprising an upright (17A; 17B) and suspension arms (11A, 13A; 11B, 13B).

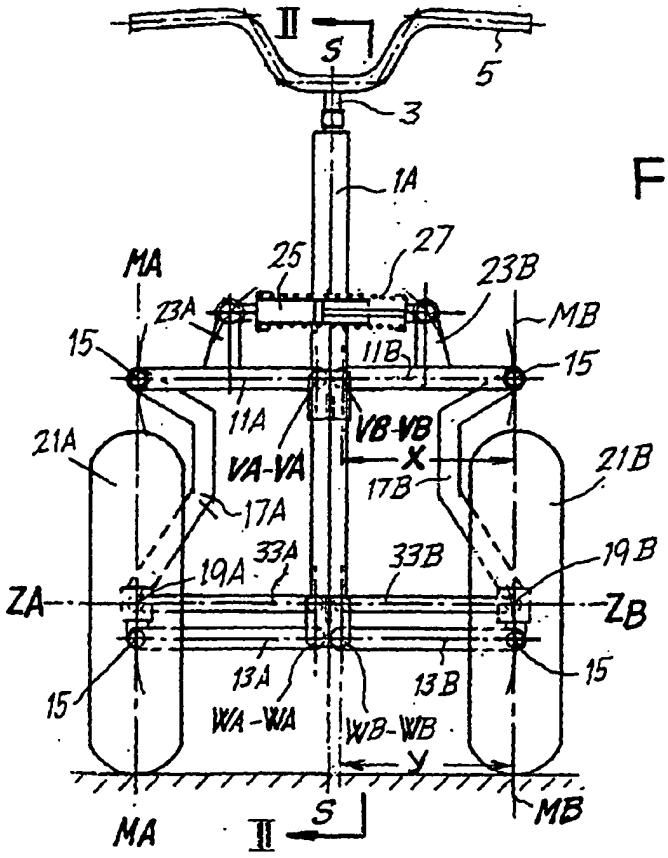

Fig. 1

wide width tires
Ackerman type steering
fig 3

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Description

[0001] The present invention relates to a three-wheeled vehicle and, more particularly, to a vehicle having two steering front wheels and a driving rear wheel.

[0002] Certain types of tilting three-wheeled scooter are already known, such as the Stream® and Canopy® of Honda and the Ellisse® scooter of Protos which is described in WO-A-9843872.

[0003] The Honda models possess two rear wheels supported by a track hinged on the frame of the scooter about the longitudinal axis thereof. The axis of the rear wheels does not tilt in curves and remains parallel to the ground.

[0004] The scooter described in WO-A-9843872 likewise has two rear wheels, each of which is articulated on the frame by means of a longitudinal arm. The arms are in turn linked by means of an equalizer element hinged about an axis longitudinal to the vehicle on a pivoting bracket of an elastic suspension. Said vehicle possesses the advantage over said Honda models that, in curves, the rear wheels also tilt with the vehicle. This fact increases the directional control of the vehicle in that, in curves, wheels tilted in this way deviate less than those which do not tilt.

[0005] All the abovementioned models therefore refer to tilting vehicles fitted with two rear wheels. Said arrangement considerably complicates the mechanical transmission of the drive to the wheels, with the disadvantage of a high production cost. In particular, a differential system is made necessary for transmitting the power to the wheels.

[0006] Three-wheeled vehicles are also known having one driving rear wheel and two steering front wheels, but for these no elastic suspension is provided. An example of a scooter of this type is described in Italian Utility Model Application 15179B/80, applied for on April 30, 1980 in the name of Tartarini.

[0007] The object of the present invention is to provide a laterally tilting three-wheeled vehicle having two steering front wheels, which is of modest cost and is easy and safe to drive. More particularly, an object of the present invention is to produce a three-wheeled vehicle having better roadholding than the three-wheeled vehicles currently known.

[0008] These and other objects and advantages which will become apparent to those skilled in the art from reading the text which follows are substantially obtained with a three-wheeled vehicle comprising a driving rear wheel and two steering front wheels with respective steering axes, wherein a system, with viscoelastic suspension, is provided for connecting said wheels to the frame of the vehicle. The suspension system makes it possible to obtain tilting of the steering axes of the wheels when the frame tilts in curves. The deviation of the tires of the wheels during steering is thus minimized and roadholding in curves is improved.

[0009] According to a particularly advantageous embodiment of the vehicle according to the invention, provision is made for the system connecting the two steering wheels to the frame to possess, for each steering wheel, an articulated quadrilateral comprising an upper suspension arm, a lower suspension arm and an upright disposed between the two arms and articulated thereon by means of ball joints. The upper and lower suspension arms are hinged on the frame about respective pivot axes disposed parallel and symmetrically on opposite sides of the median plane of the vehicle.

[0010] In an arrangement of this type, provision may advantageously be made for the distance between the ball joint and the pivot axis of each upper suspension arm of each quadrilateral to be approximately equal to the distance between the ball joint and the pivot axis of each lower arm.

[0011] Preferably, the axis which passes through the ball joints of the upright of each steering wheel and which defines the steering axis of said wheel is contained within the median plane of the respective wheel. This prevents the irregularities of the road from transmitting bumps and vibrations to the driver via the steering control (in practice, the handlebar attached to the steering column), bumps and vibrations instead being absorbed by the frame of the vehicle. This makes driving particularly easy and pleasant.

[0012] In practice, the articulated quadrilateral formed by the upper and lower arms, the upright and the frame is preferably an articulated parallelogram, with the upper and lower arms remaining mutually parallel during the tilting of the wheels.

[0013] A steering linkage is associated with the suspension system. It may be adjacent to the lower pair of arms or alternatively to the upper pair of suspension arms. The choice of the position of the linkage depends on the specific configuration of the vehicle on which the suspension system is being produced, on the basis of component sizes and available space.

[0014] The linkage may possess, according to a practical embodiment, connecting rods having at their ends ball joints for connection to the steering and to the wheels, respectively. In this case, it is particularly advantageous if the centers of the ball joints of each connecting rod of said linkage possess, in projection onto a plane orthogonal to the axis of rotation of the suspension arms, a mutual separation substantially equal to the distance between the ball joint and the pivot axis of the suspension arms. In this way, the steering orientation of the wheels is preserved even during oscillations of the suspension, independently of the lateral tilting of the vehicle.

[0015] When the steering axis of each wheel is contained within the median plane of the respective wheel, then - according to a particularly advantageous embodiment of the invention - in order to achieve correction of the steering angle of the wheels so that the wheel on the outside of the curve steers less than the inside wheel, it is provided that the centers of the ball joints

which connect each rod of said linkage to the steering are mutually spaced and disposed on opposite sides of the median plane of the vehicle.

[0016] The viscoelastic means of the suspension may be linked to two opposite suspension arms - in other words, for example, to the two upper suspension arms or to the two lower suspension arms. In this manner, a single suspension system, comprising for example a spring/shock absorber assembly, provides for the elastic suspension of both wheels.

[0017] The suspension arms with which the spring/shock absorber assembly is associated, for example the upper arms, are in this case articulated on the frame about a common axis of articulation or two slightly spaced axes of articulation, but in either case pivot independently of one another, opposed by the spring/shock absorber assembly.

[0018] However, the possibility is not ruled out that a pair of opposing arms may be solidly fixed to one another, forming a cross-piece articulated centrally on the frame of the vehicle. In this case, a respective spring/shock absorber assembly is provided for each wheel, fitting in the upright of the associated articulated quadrilateral.

[0019] Further advantageous embodiments of the vehicle according to the invention are described in the attached dependent claims.

[0020] The invention will be better understood with reference to the description and the attached drawing, which shows a non-limiting example of said invention. In the drawing:

Figs 1 and 2 show diagrammatic views, from the front and side respectively, of the front part of a scooter equipped with a pair of steering front wheels according to a first embodiment of the invention, the scooter in the lateral view being sectioned in a vertical plane marked II-II in Fig. 1;

Fig. 3 shows a view of the steering assembly, sectioned in a plane shown as III-III in Fig. 2, orthogonal to the steering axis of the wheels;

Figs 4 and 5 show partial frontal views, analogous to that in Fig. 1, in respective different attitudes of the elastic suspension;

Fig. 6 shows a view analogous to that in Fig. 1, but with the scooter tilted laterally;

Figs 7 and 8 show views analogous to those in Figs 1 and 2, respectively, for a second embodiment of the invention; and

Fig. 9 shows a diagrammatic perspective view of a vehicle according to the invention.

[0021] With reference to Figs 1 and 2, the scooter comprises a frame 1 which possesses at the front a tubular sleeve 1A into which is rotably inserted a steering column 3 fitted with a handlebar 5. The axis S-S of the sleeve lies in the median plane of the vehicle and is tilted relative to the vertical in the interests of greater practicality and as a function of the position of the handlebar. At the rear, a single driving wheel 22 is provided (Fig. 9).

[0022] Welded to the sleeve 1A are an upper bracket 7 and a lower bracket 9 forming hinges for respective pairs of upper suspension arms 11A, 11B and lower suspension arms 13A, 13B. The suspension arms 11A, 11B and 13A, 13B may also be hinged on the frame in another manner instead of by means of the brackets 7 and 9, depending on the design requirements.

[0023] The suspension arms of each of said pairs are disposed symmetrically on opposite sides relative to the median plane of the vehicle. The pivot axes VA, VB; WA, WB of the various arms lie in respective planes parallel to the median plane of the vehicle and perpendicular to the steering axis of the wheels. Each upper suspension arm 11 A; 11B and lower suspension arm 13A; 13B is articulated in turn - at the opposite end from the pivot axis - by means of respective ball joints 15 on corresponding upper and lower ends of respective uprights 17A; 17B. In this manner, each pair of arms, upper and lower, forms, with the respective upright and the sleeve 1A, an articulated quadrilateral 11A, 17A, 13A and 11B, 17B, 13B.

[0024] The axes VA-VA, VB-VB and WA-WA, WB-WB are orthogonal to the axes MA-MA and MB-MB which join the upper and lower ball joints 15 of each upright 17A, 17B. The ball joint 15 of each upper arm 11A; 11B is set apart from the pivot axis VA-VA; VB-VB of said arm by a segment X (Fig. 1) equal and parallel to the analogous segment Y of the corresponding lower arm 13A; 13B. Pivoted on each upright, by means of a conventional bearing/axle assembly 19A; 19B, is a respective front wheel 21A; 21B to revolve about a respective horizontal axis ZA-ZA; ZB-ZB.

[0025] Furthermore, the axis MA-MA; MB-MB which passes through the two, upper and lower ball joints 15 of the upright 17A; 17B of each steering wheel 21A; 21B and defines the steering axis of said wheel is contained in the median plane of the wheel and, in the example shown, is parallel to the axis S-S of the steering column 3. The tilt α of the axes MA-MA and MB-MB is not necessarily equal to the tilt of the steering axis S-S and is determined on the basis of considerations known to the person skilled in the art in order to obtain an appropriate compromise between stability and maneuverability of the vehicle.

[0026] In the example shown, the upper suspension arms 11A; 11B possess respective transverse extensions 23A; 23B that are symmetrical relative to the median plane of the vehicle and turned upward. Articulated on the ends of said extensions are respective ends of a fluid shock absorber 25 and of a large spring 27 which tends to move them apart. The elastic suspension permits a vertical travel of the front part of the vehicle between two, lower and upper end positions, as shown in Figs 4 and 5.

[0027] Fixed to the lower end of the steering column 3 is a central link rod 29 oriented parallel to the median

plane of the wheels 21 A, 21B and linked by means of ball joints 31 and connecting rods 33A; 33B which are in turn connected via ball joints 32 to the ends of respective lateral link rods 35A; 35B. Each lateral link rod 35A; 35B is solidly fixed to the respective upright 17A; 17B of the suspension, and the center of the ball joint 32 of each lateral link rod lies in the median plane of the respective wheel 21A, 21B.

[0028] The joints 31 of the central link rod 29 are disposed symmetrically at the side of the axis of said link rod and their centers are set apart by a segment T so as to differentiate, in curves, the steering angle of the outer wheel from that of the inner wheel in order to obtain correct steering. This arrangement makes it possible to obtain correct steering while keeping the joints 32 on the center line of the wheel. The distance T is advantageously equal to the center distance between the axes VA-VA and VB-VB and the center distance between the axes WA-WA and WB-WB. In this manner, correct steering behavior in curves is obtained.

[0029] Each connecting rod 33A; 33B has a length such that its projection onto a plane orthogonal to the pivot axes of the suspension arms 11A, 11B; 13A, 13B has a length equal to the characteristic segment (X, Y) of the arms. In this manner, the joltings permitted by the suspension do not change the annular position of each wheel defined by the angular attitude of the handlebar 5, preventing disruption to the steering and minimizing tire wear.

[0030] As shown in Fig. 6, the system described permits lateral tilting of the vehicle, for example through an angle β, in particular to offset the centrifugal force when cornering. In the example shown, the pivot axes of the upper arms 11A; 11 B are set apart from one another by a segment P, but it is not impossible for the two pivot axes to coincide, without preventing independent oscillation of the two suspension arms.

[0031] In a second embodiment of the invention (Figs 7 and 8), the system for connecting the steering front wheels to the frame comprises respective articulated suspension quadrilaterals 111A, 117A, 113A, 101A; 111B, 117B, 113B, 101A in which the upper arms 111 are rigidly connected to one another so as to form a cross-piece articulated in the central region about a pivot of axis V-V on the steering sleeve 101A.

[0032] Furthermore, between the upper part of the uprights 117A; 117B and the ball joints 115 of the upper arms 111A; 111B, respective fluid shock absorbers 125A; 125B are interposed, having respective compression springs 127A; 127B to form elastic suspensions of the MacPherson type. The steering linkage is analogous to that described in the previous case and is not shown in the drawing. In this case, the lengths X and Y of the upper and lower arms are not identical, as they were in the previous case.

[0033] It is understood that the drawing shows only an example, given solely by way of a practical demonstration of the invention, said invention being capable of variation in shape and disposition without thereby departing from the scope of the idea underlying said invention. The presence of any reference numbers in the appended claims is intended to facilitate reading of the claims with reference to the description and does not limit the scope of protection represented by the claims.

Claims

1. A three-wheeled vehicle, comprising a driving rear wheel (22) and two steering front wheels (21A, 21B) with respective steering axes (MA-MA, MB-MB), **characterized in that** it comprises a system, with viscoelastic suspension, for connecting said wheels to the frame of the vehicle such that a lateral tilting of the frame is accompanied by an equal tilting of their steering axes (MA-MA, MB-MB).

2. Vehicle according to claim 1, **characterized in that** said system connecting the two steering wheels to the frame possesses, for each steering wheel, an articulated quadrilateral comprising an upper suspension arm (11A; 11B; 111A, 111B) and a lower suspension arm (13A, 13B; 113A, 113B) articulated on an upright (17A, 17B; 117A, 117B) by means of ball joints (15; 115), the upper and lower suspension arms being hinged on the frame (1; 101) about respective pivot axes (VA-VA, WA-WA, VB-VB, WB-WB; V-V) parallel to the median plane of the vehicle and orthogonal to the steering axes.

3. Vehicle according to claim 2, **characterized in that** the pivot axes of two opposite suspension arms are disposed symmetrically on opposite sides of the median plane of the vehicle.

4. Vehicle according to claim 2 or 3, **characterized in that** the distance (X) between the ball joint (15; 115) and the pivot axis (VA-VA, VB-VB; V-V) of each upper suspension arm (11A, 11B; 111A, 111B) is approximately equal to the distance (Y) between the ball joint (15; 115) and the pivot axis (WA-WA, WB-WB; HA-HA, HB-HB) of each lower arm (13A, 13B; 113A, 113B).

5. Vehicle according to claim 2, 3 or 4, **characterized in that** the axis (MA-MA; MB-MB) which passes through said ball joints of the upright of each steering wheel (21A; 21B) and which defines the steering axis of said wheel is contained within the median plane of the respective wheel.

6. Vehicle according to one or more of claims 2 to 5, **characterized in that** each of said articulated quadrilaterals is an articulated parallelogram.

7. Vehicle according to one or more of the preceding

claims, **characterized in that** it comprises a steering linkage equipped with connecting rods (33A; 33B) having at their ends ball joints (31, 32) for connection to the steering and to the wheels, respectively.

8. Vehicle according to claims 4 and 7, **characterized in that** the centers of the ball joints (31, 32) of each connecting rod of said linkage possess, in projection onto a plane orthogonal to the axis of rotation of the suspension arms (13A; 13B), a mutual separation substantially equal to the distance between the ball joint (15; 115) and the pivot axis (VA, VB, WA, WB; V; HA-HA, HB-HB) of said suspension arms (11A, 11B; 13A, 13B; 111A, 111B; 113A, 113B).

9. Vehicle according to claim 7 or 8, **characterized in that** the centers of the ball joints (31) which connect each rod of said linkage to the steering are mutually spaced (T) and disposed on opposite sides of the median plane of the vehicle in order to achieve correction of the steering angle of the wheels (21A, 21B).

10. Vehicle according to any one of claims 2 to 9, **characterized in that** said viscoelastic means are interposed between the upper suspension arms (11A, 11B) or between the lower suspension arms (13A, 13B), the arms between which said viscoelastic means are interposed being articulated independently of one another on the frame.

11. Vehicle according to claim 10, **characterized in that** said viscoelastic means comprise a spring (27) and a shock absorber (25) operating jointly between transverse extensions (23A; 23B) solidly fixed to two corresponding suspension arms (11A; 11B).

12. Vehicle according to one or more of claims 2 to 11, **characterized in that** the axes of articulation (VA-VA, VB-VB; WA-WA, WB-WB) on the frame (1) of said upper suspension arms (11A; 11B) and of said lower suspension arms (13A, 13B) are mutually spaced.

13. Vehicle as claimed at least in claim 2, **characterized in that** the upper suspension arm (111A) of one wheel is solidly fixed to the upper suspension arm (111B) of the other wheel, forming a cross-piece hinged in the median part on the frame (101 A) of the vehicle, the upright (117A; 117B) of each wheel comprising a shock absorber (125; 125B) and a spring (127A; 127B) operating jointly and interposed between the upright (117A; 117B) and one of the ball joints (115) connecting the upright to the suspension arms.

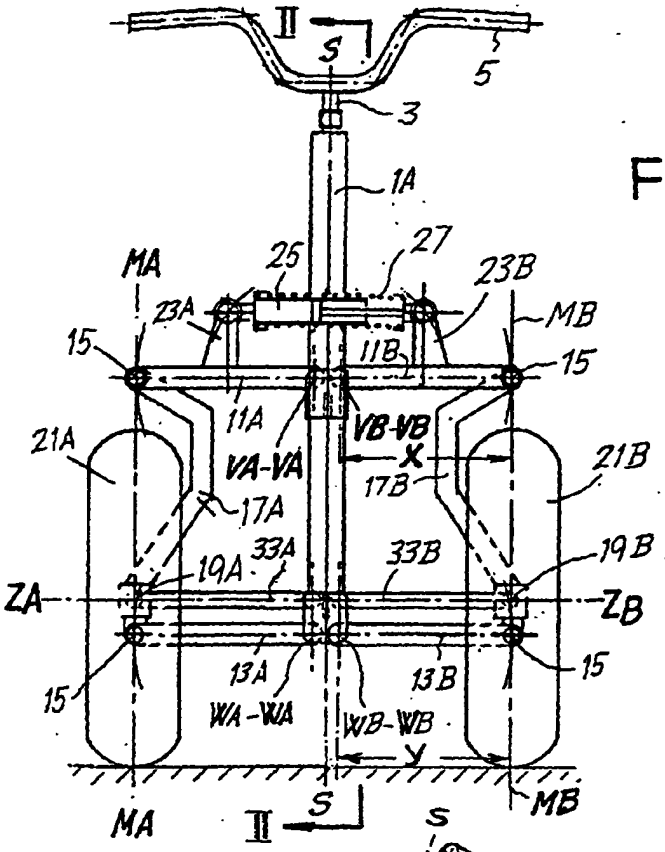


Fig. 1

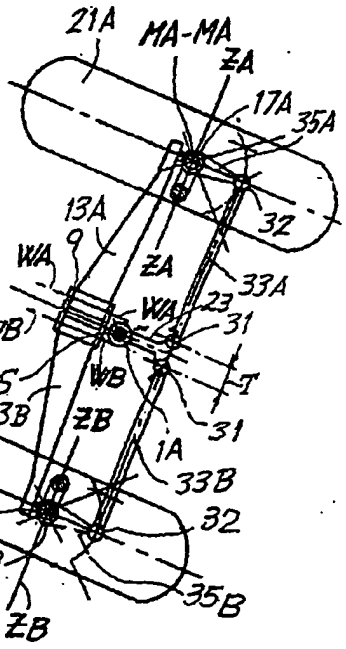


Fig.3

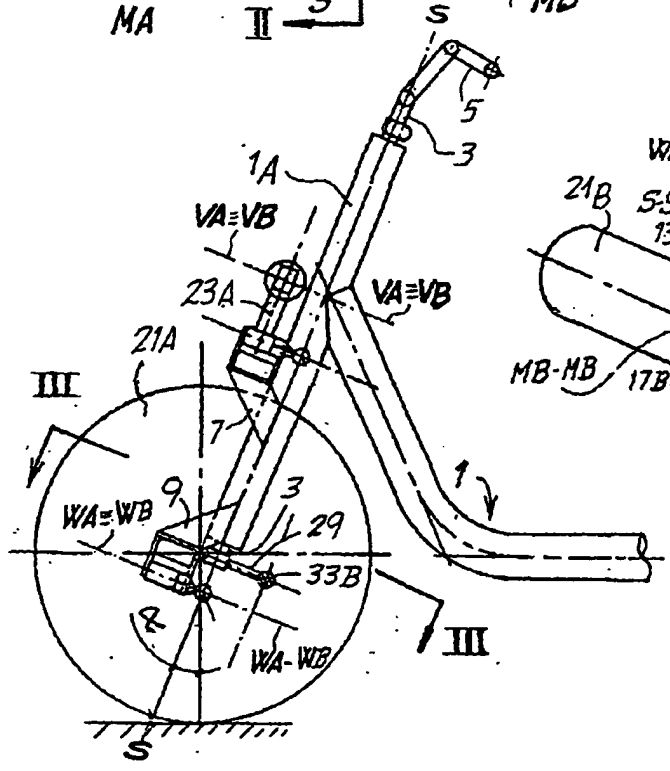


Fig.2

Fig. 6

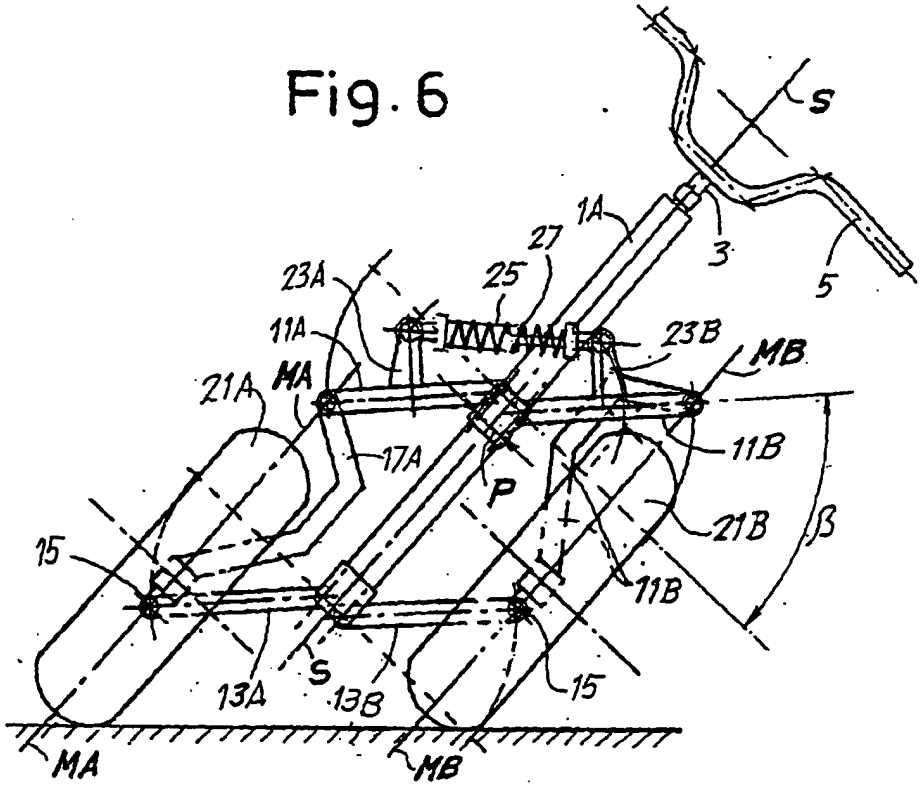


Fig. 4

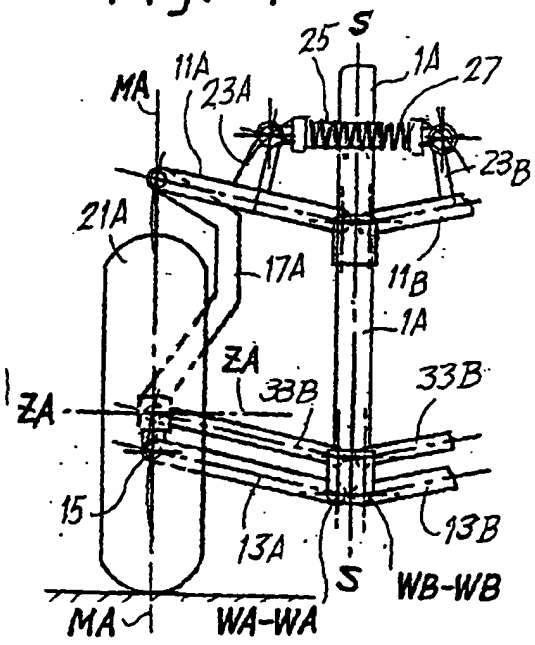
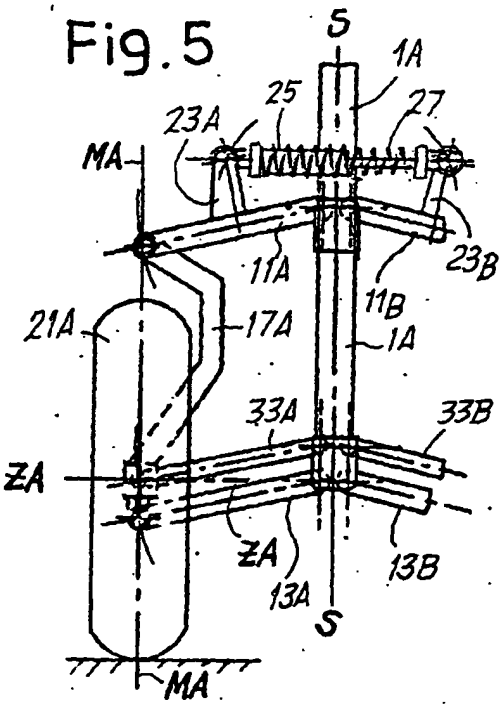


Fig. 5



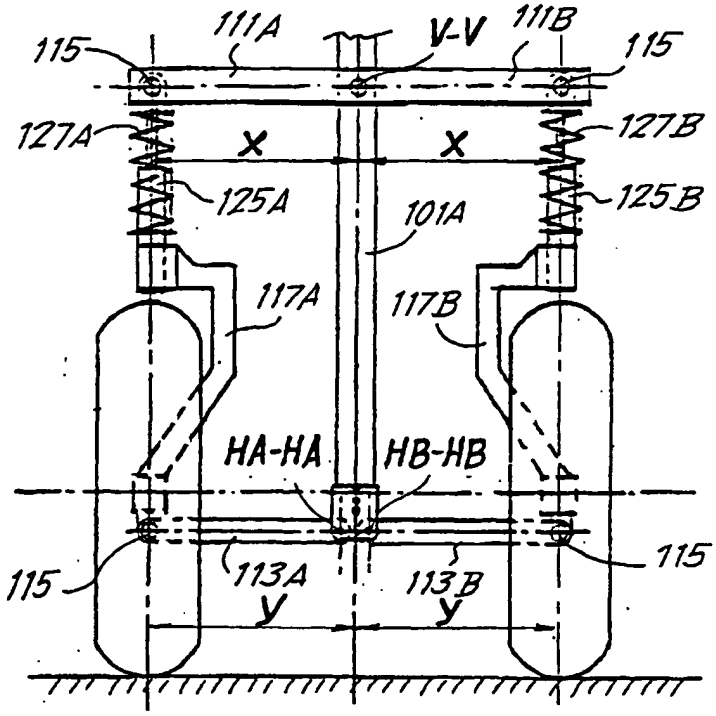

111A
V-V
111B
115
115
127A
X
X
127B
125A
101A
125B
117A
117B
HA-HA
HB-HB
115
115
113A
113B
Y
Y

Fig. 7

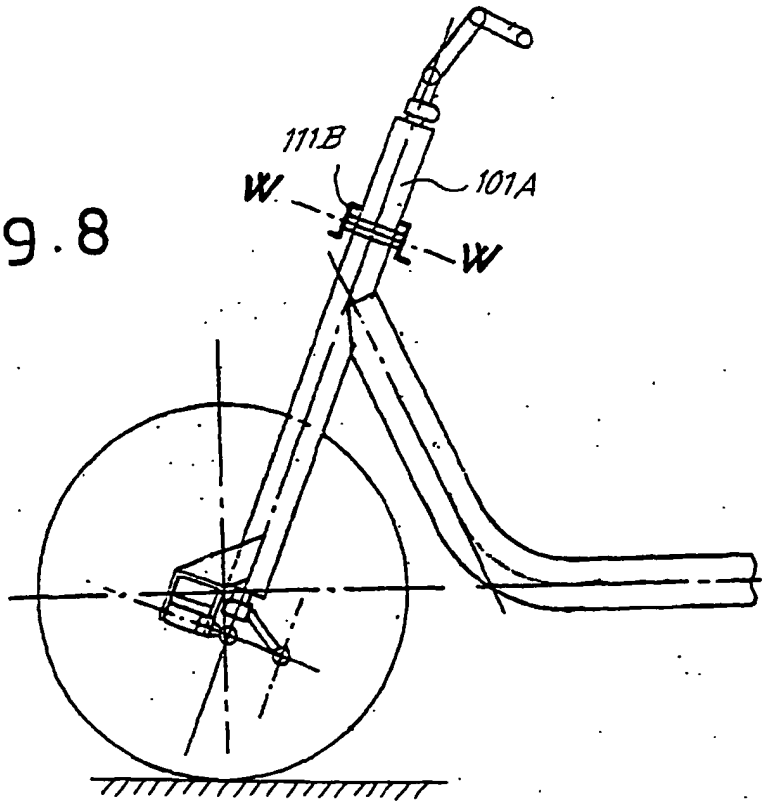

111B
W
101A
W

Fig. 8

Fig.9

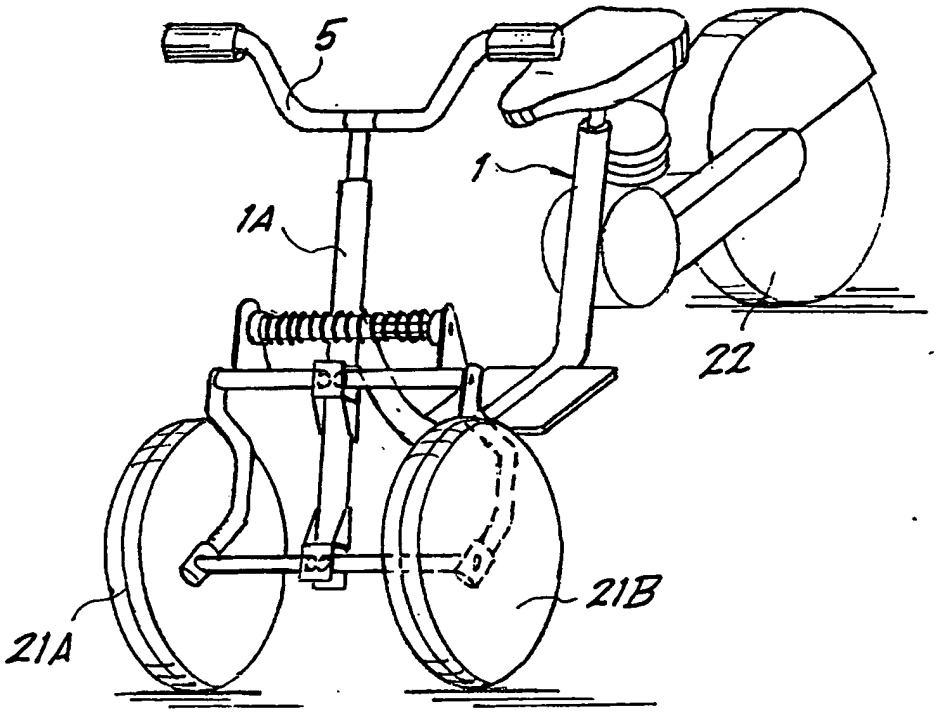


fig 1
wide front wheels
w/ respect to handlebar stem
Appears > than 3"

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EUROPEAN SEARCH REPORT

Application Number
EP 00 83 0572

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 97 21583 A (MUCCIO ROMEO) 19 June 1997 (1997-06-19) * page 2, line 30 - page 4, line 3; figures *	1-7	B62K5/04 B62K5/08
X	GB 2 279 047 A (DOVISON DAVID) 21 December 1994 (1994-12-21) * page 3, line 38 - line 17; figure 2 * * page 16, line 39 - line 47; figure 34 * * page 13, line 47 - line 498; figure 27A *	1-6, 10-13	
X	DE 198 38 328 C (SCHLIEWERT FRANK) 16 December 1999 (1999-12-16) * column 3, line 56 - column 5, line 18; figures *	1-4,6-9	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B62K
B62D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 December 2000	Grunfeld, M

CATEGORY OF CITED DOCUMENTS

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13-12-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9721583 A	19-06-1997	IT RM950812 A AU 1170397 A	13-06-1997 03-07-1997
GB 2279047 A	21-12-1994	NONE	
DE 19838328 C	16-12-1999	NONE	

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